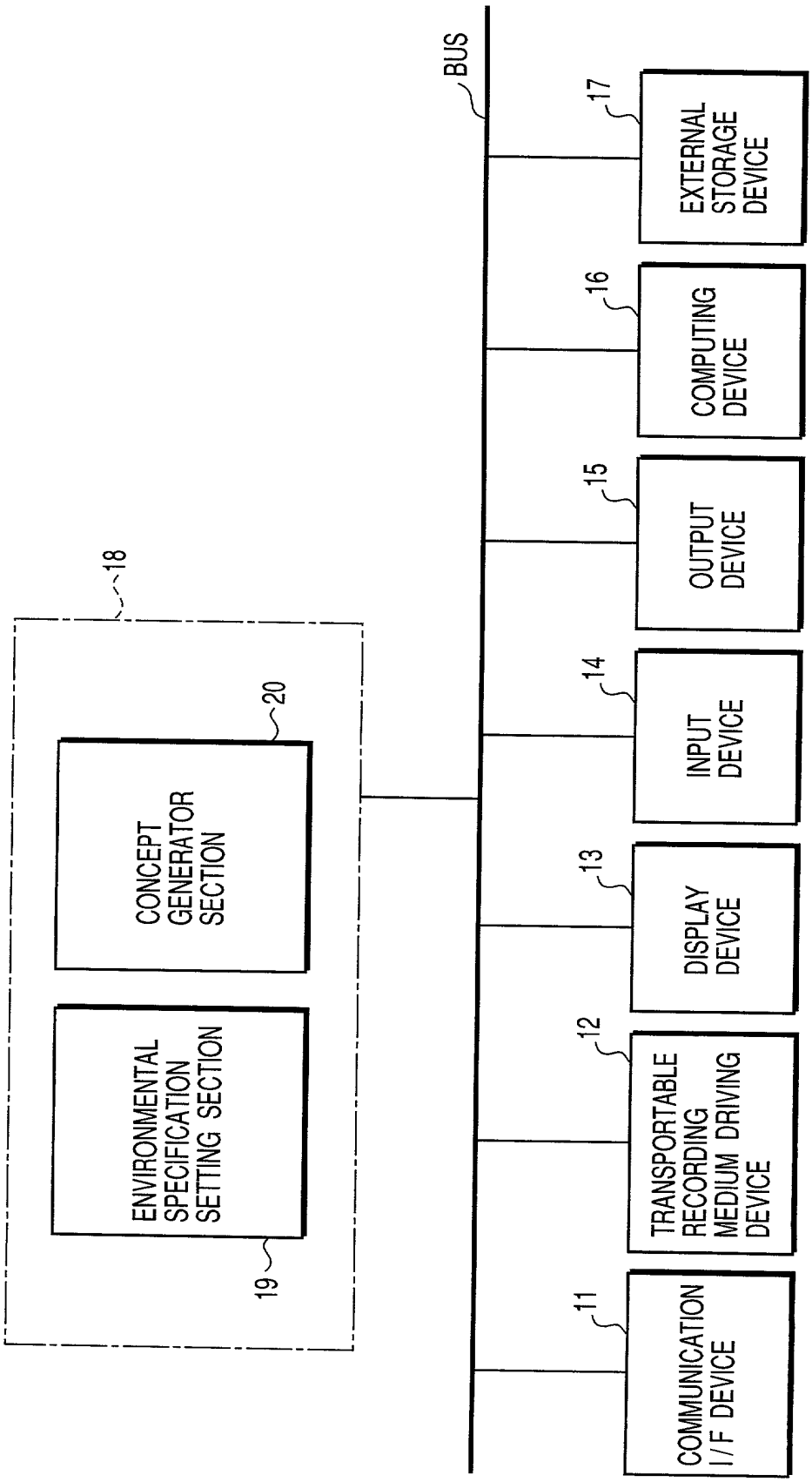
BUS
11
COMMUNICATION I/F DEVICE
12
TRANSPORTABLE RECORDING MEDIUM DRIVING DEVICE
13
DISPLAY DEVICE
14
INPUT DEVICE
15
OUTPUT DEVICE
16
COMPUTING DEVICE
17
EXTERNAL STORAGE DEVICE
18
19
ENVIRONMENTAL SPECIFICATION SETTING SECTION
20
CONCEPT GENERATOR SECTION

FIG. 1

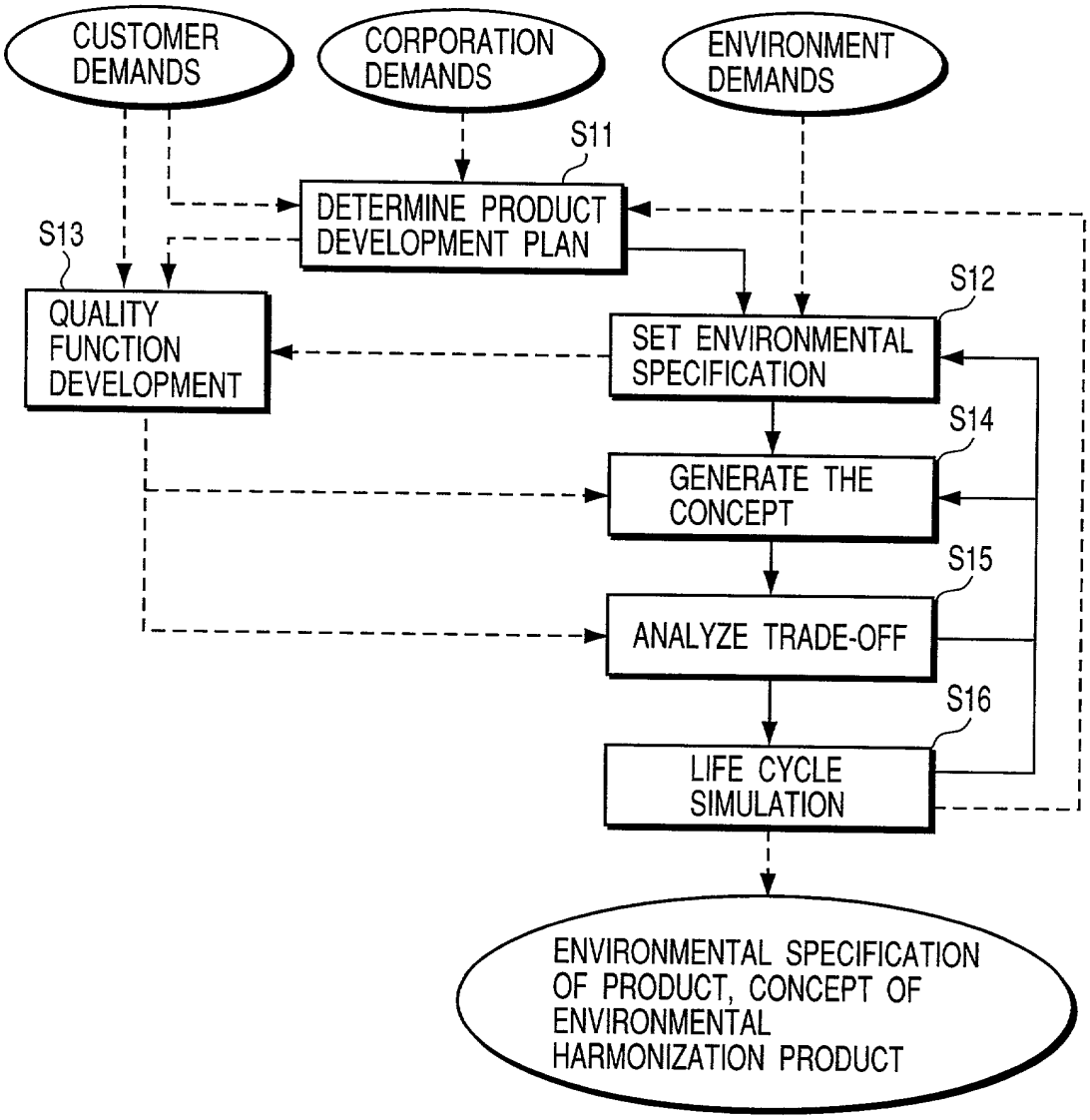
CUSTOMER DEMANDS
CORPORATION DEMANDS
ENVIRONMENT DEMANDS
S11
DETERMINE PRODUCT DEVELOPMENT PLAN
S13
QUALITY FUNCTION DEVELOPMENT
S12
SET ENVIRONMENTAL SPECIFICATION
S14
GENERATE THE CONCEPT
S15
ANALYZE TRADE-OFF
S16
LIFE CYCLE SIMULATION
ENVIRONMENTAL SPECIFICATION OF PRODUCT, CONCEPT OF ENVIRONMENTAL HARMONIZATION PRODUCT

FIG. 2

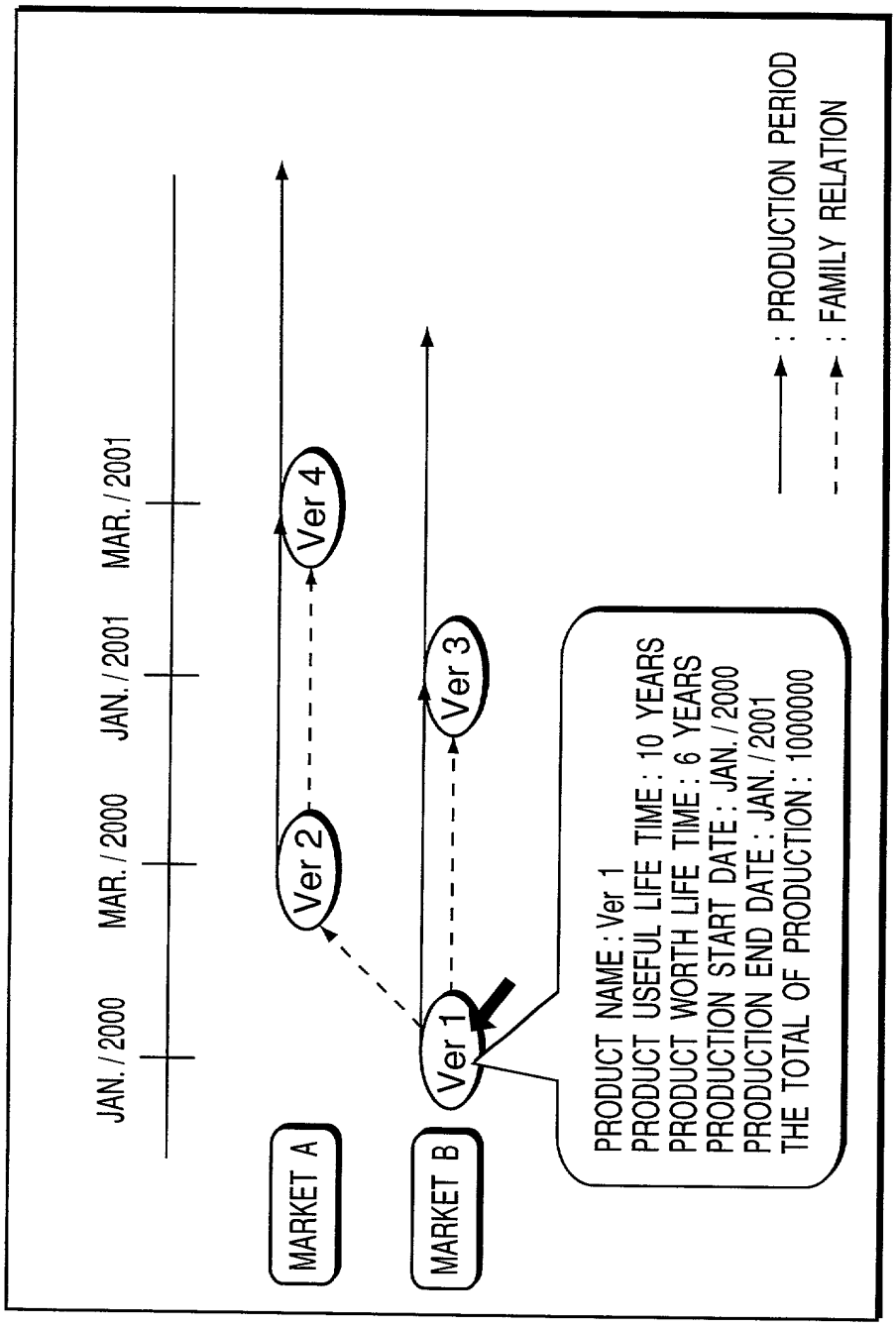
JAN. / 2000
MAR. / 2000
JAN. / 2001
MAR. / 2001
MARKET A
MARKET B
Ver 1
Ver 2
Ver 3
Ver 4
PRODUCT NAME : Ver 1
PRODUCT USEFUL LIFE TIME : 10 YEARS
PRODUCT WORTH LIFE TIME : 6 YEARS
PRODUCTION START DATE : JAN. / 2000
PRODUCTION END DATE : JAN. / 2001
THE TOTAL OF PRODUCTION : 1000000
: PRODUCTION PERIOD
: FAMILY RELATION

FIG. 3

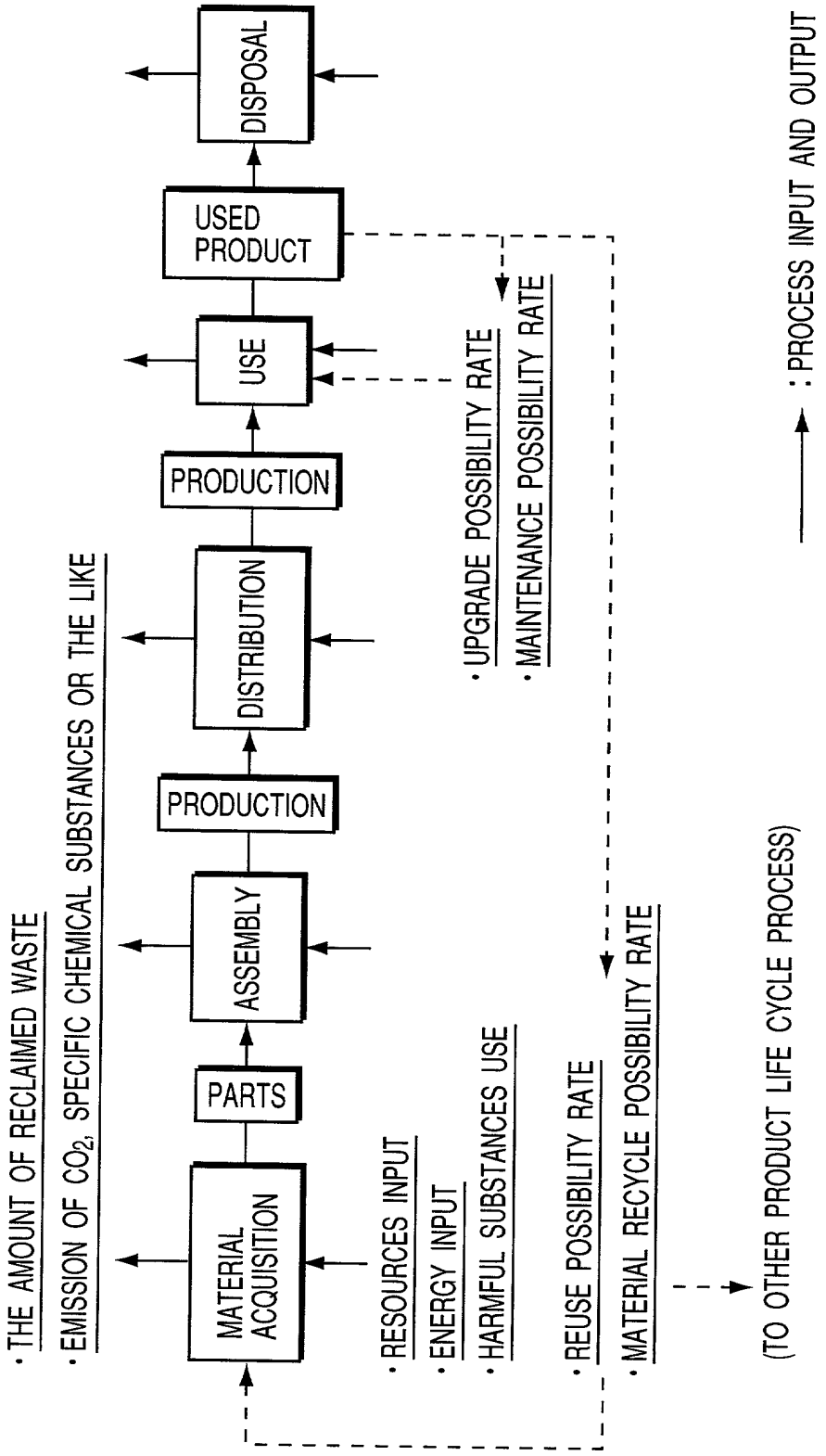
MATERIAL ACQUISITION
PARTS
ASSEMBLY
PRODUCTION
DISTRIBUTION
PRODUCTION
USE
USED PRODUCT
DISPOSAL
• THE AMOUNT OF RECLAIMED WASTE
• EMISSION OF CO_2, SPECIFIC CHEMICAL SUBSTANCES OR THE LIKE
• RESOURCES INPUT
• ENERGY INPUT
• HARMFUL SUBSTANCES USE
• UPGRADE POSSIBILITY RATE
• MAINTENANCE POSSIBILITY RATE
• REUSE POSSIBILITY RATE
• MATERIAL RECYCLE POSSIBILITY RATE
(TO OTHER PRODUCT LIFE CYCLE PROCESS)
: PROCESS INPUT AND OUTPUT
: LIFE CYCLE OPTION

FIG. 4

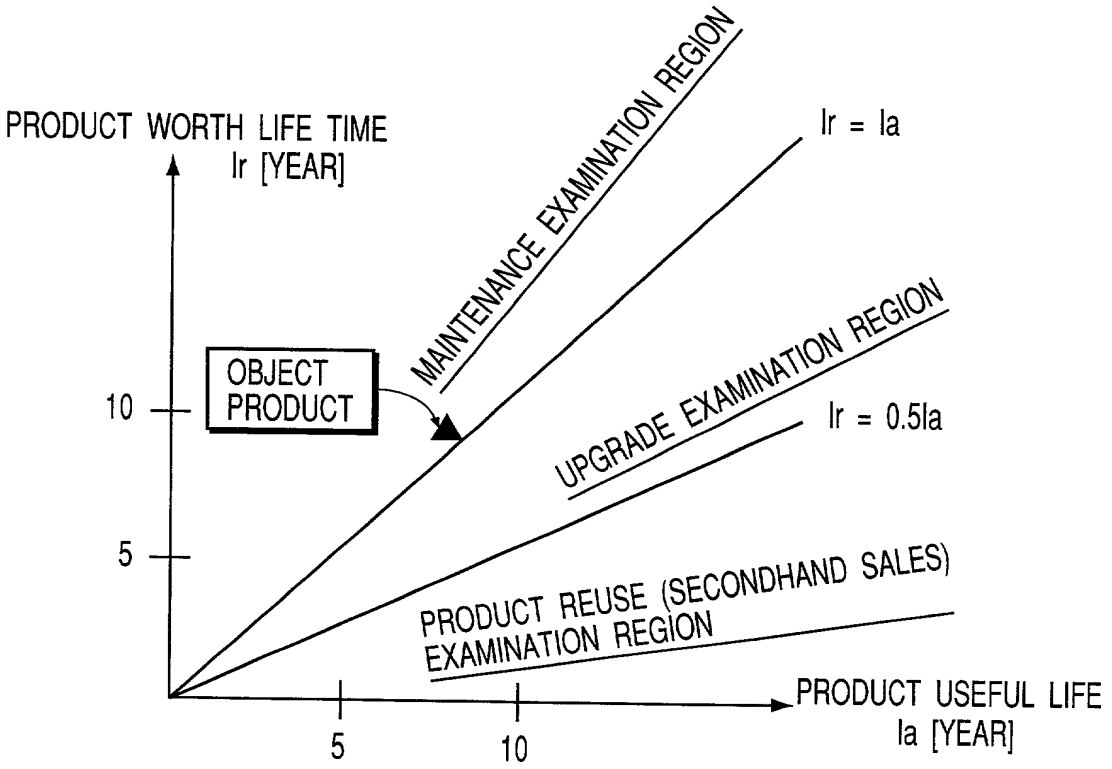
PRODUCT WORTH LIFE TIME
Ir [YEAR]
MAINTENANCE EXAMINATION REGION
Ir = Ia
OBJECT PRODUCT
10
5
UPGRADE EXAMINATION REGION
Ir = 0.5Ia
PRODUCT REUSE (SECONDHAND SALES) EXAMINATION REGION
PRODUCT USEFUL LIFE
Ia [YEAR]
5
10

FIG. 5A

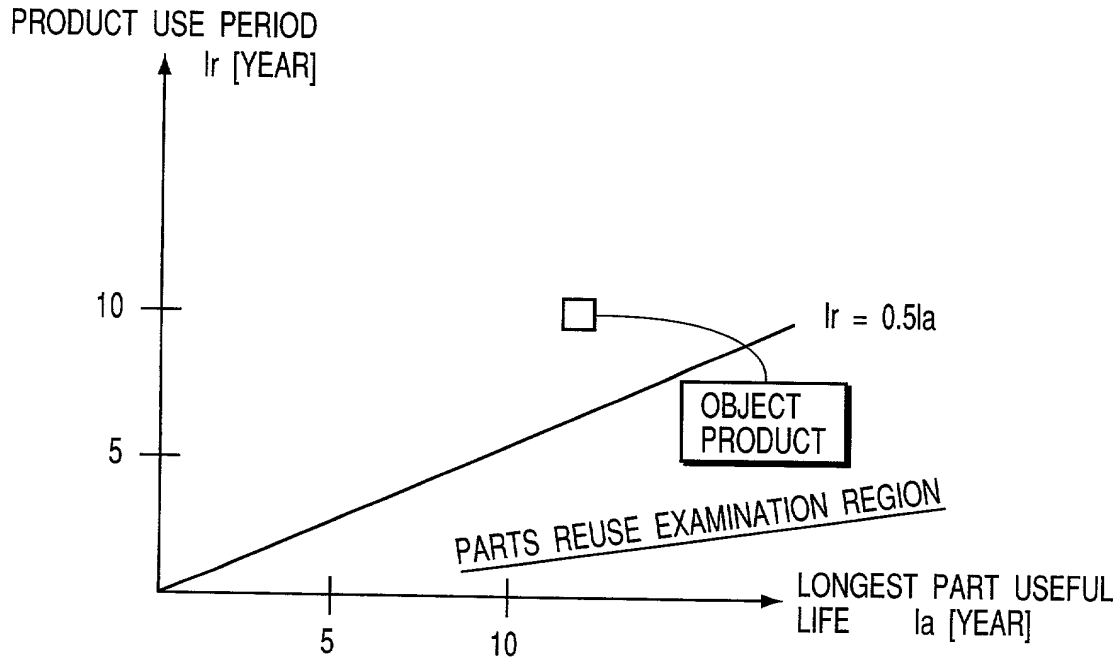
PRODUCT USE PERIOD
Ir [YEAR]
10
5
Ir = 0.5Ia
OBJECT PRODUCT
PARTS REUSE EXAMINATION REGION
LONGEST PART USEFUL LIFE
Ia [YEAR]
5
10

FIG. 5B

SUBJECT CATEGORY	LIFE CYCLE STEPS	ENVIRONMENT DEMANDS	MUST/WANT				ENVIRONMENTAL CHARACTERISTIC	TARGET VALUE			
			Ver 1	Ver 2	Ver 3	Ver 4		Ver 1	Ver 2	Ver 3	Ver 4
SAVING RESOURCES	MATERIAL ACQUISITION										
	PRODUCTION										
	DISTRIBUTION	SIMPLIFICATION OF PACKING									
	USE	WATER USE REDUCTION	W	W	W	W	VOLUME OF WATER PER ONE TIME [L]				40
	DISPOSAL										
SAVING ENERGY	MATERIAL ACQUISITION										
	PRODUCTION										
	DISTRIBUTION										
	USE	POWER CONSUMPTION REDUCTION									
	DISPOSAL										
WASTE REDUCTION	MATERIAL ACQUISITION										
	PRODUCTION										
	DISTRIBUTION										
	USE										
	DISPOSAL	RECLAIMED DISPOSITION AMOUNT REDUCTION									

FIG. 6A

HARMFUL SUBSTANCES REDUCTION	MATERIAL ACQUISITION	ADOPTION OF LEAD-FREE SOLDER	W	W	M	M	LEAD USE [g]			0	0
	PRODUCTION										
	DISTRIBUTION										
	USE										
	DISPOSAL										
EMISSION REDUCTION	MATERIAL ACQUISITION										
	PRODUCTION										
	DISTRIBUTION										
	USE	WATER-POLLUTION REDUCTION									
	DISPOSAL										
LIFE CYCLE OPTION		UPGRADE									
LIFE CYCLE OPTION		MAINTENANCE		W	W	W	MAINTENANCE POSSIBILITY RATE [%]		80	80	90
LIFE CYCLE OPTION		PARTS REUSE		W	W	W	REUSE POSSIBILITY RATE [%]				
LIFE CYCLE OPTION		MATERIAL RECYCLE	M	M	M	M	RECYCLE POSSIBILITY RATE [%]	70	70	70	70

FIG. 6B

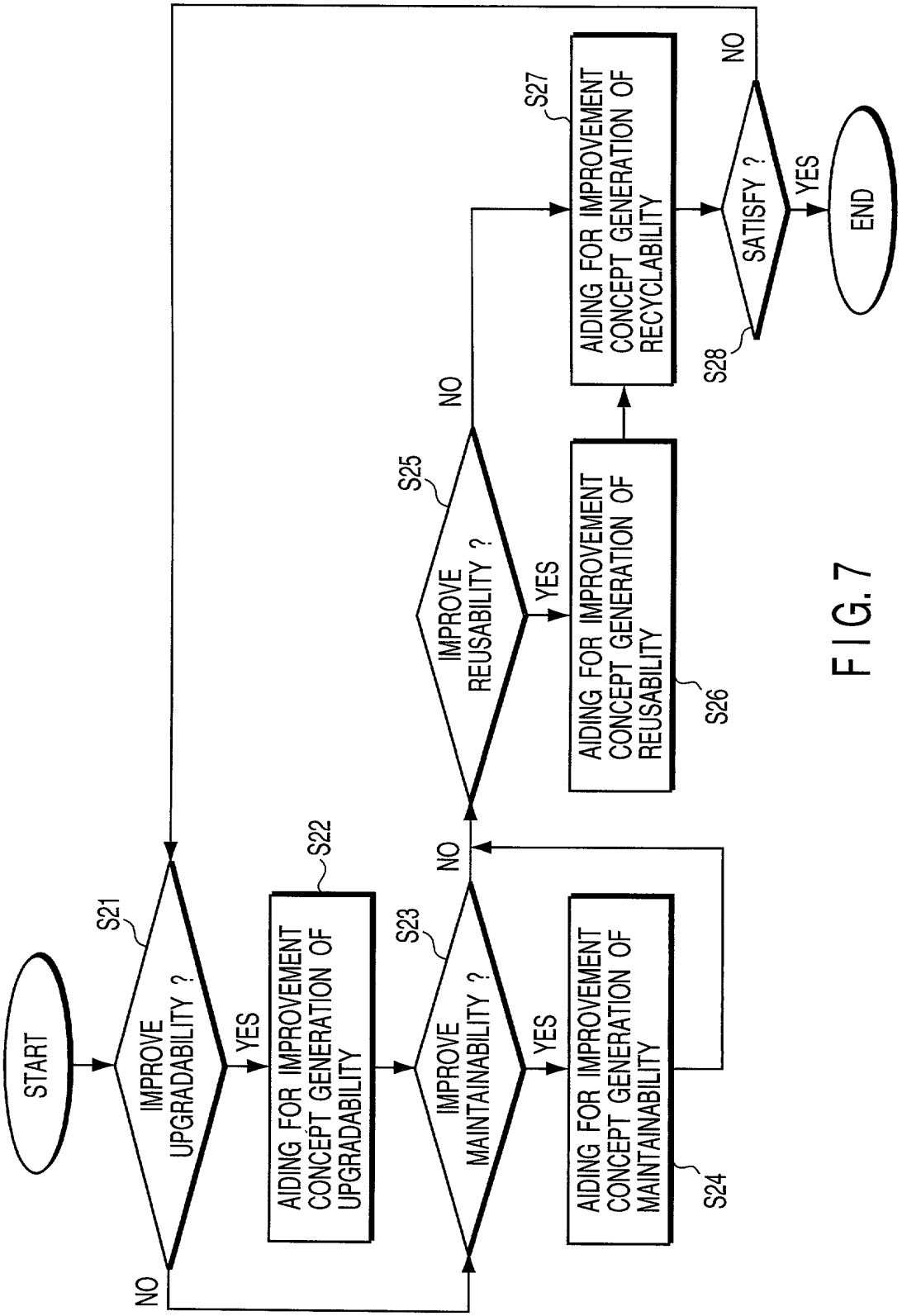
START
S21
IMPROVE UPGRADABILITY ?
YES
NO
S22
AIDING FOR IMPROVEMENT CONCEPT GENERATION OF UPGRADABILITY
S23
IMPROVE MAINTAINABILITY ?
YES
NO
S24
AIDING FOR IMPROVEMENT CONCEPT GENERATION OF MAINTAINABILITY
S25
IMPROVE REUSABILITY ?
YES
NO
S26
AIDING FOR IMPROVEMENT CONCEPT GENERATION OF REUSABILITY
S27
AIDING FOR IMPROVEMENT CONCEPT GENERATION OF RECYCLABILITY
S28
SATISFY ?
YES
NO
END

FIG. 7

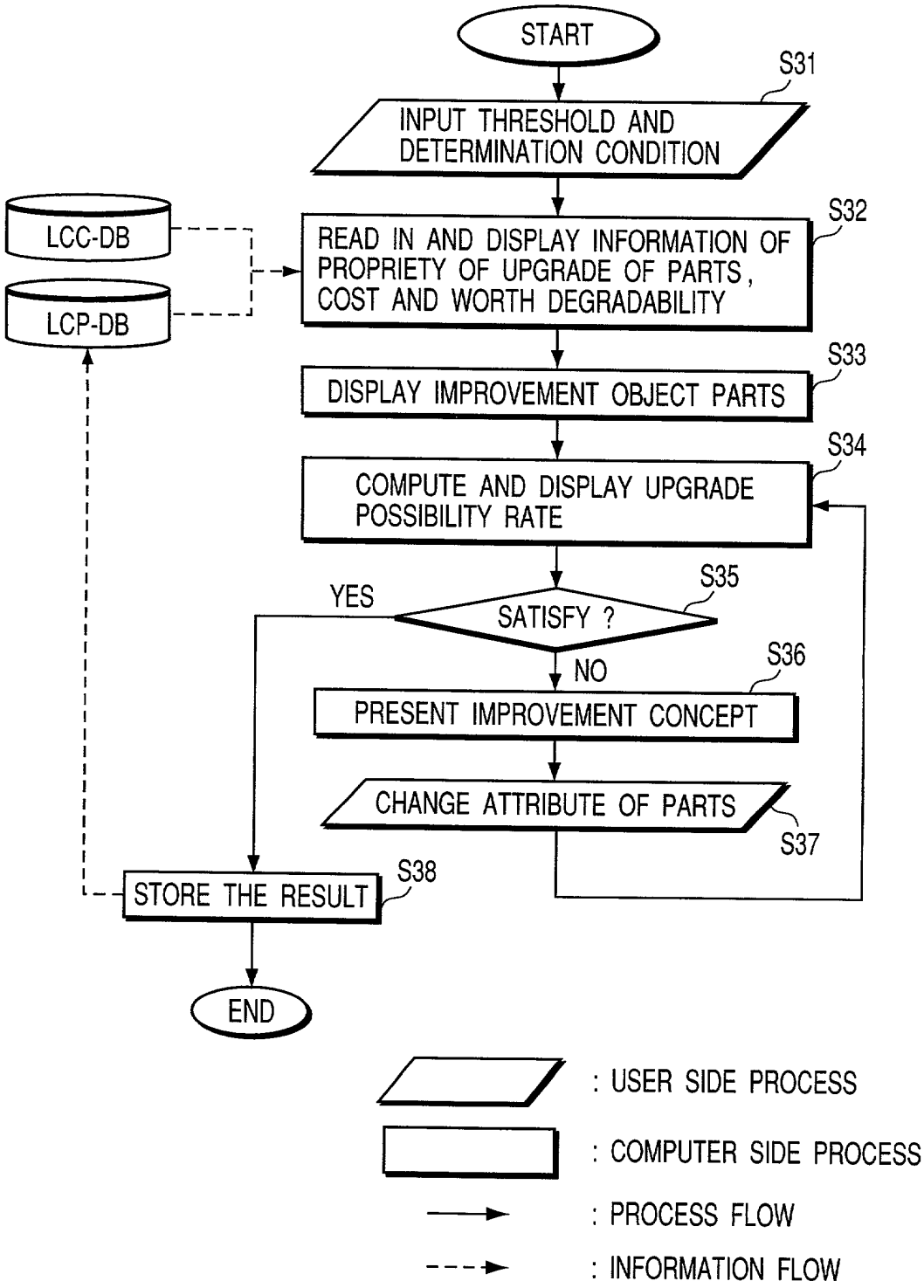
START
S31
INPUT THRESHOLD AND DETERMINATION CONDITION
LCC-DB
LCP-DB
READ IN AND DISPLAY INFORMATION OF PROPRIETY OF UPGRADE OF PARTS, COST AND WORTH DEGRADABILITY
S32
DISPLAY IMPROVEMENT OBJECT PARTS
S33
COMPUTE AND DISPLAY UPGRADE POSSIBILITY RATE
S34
YES
SATISFY ?
S35
NO
PRESENT IMPROVEMENT CONCEPT
S36
CHANGE ATTRIBUTE OF PARTS
S37
STORE THE RESULT
S38
END
: USER SIDE PROCESS
: COMPUTER SIDE PROCESS
: PROCESS FLOW
: INFORMATION FLOW

FIG. 8

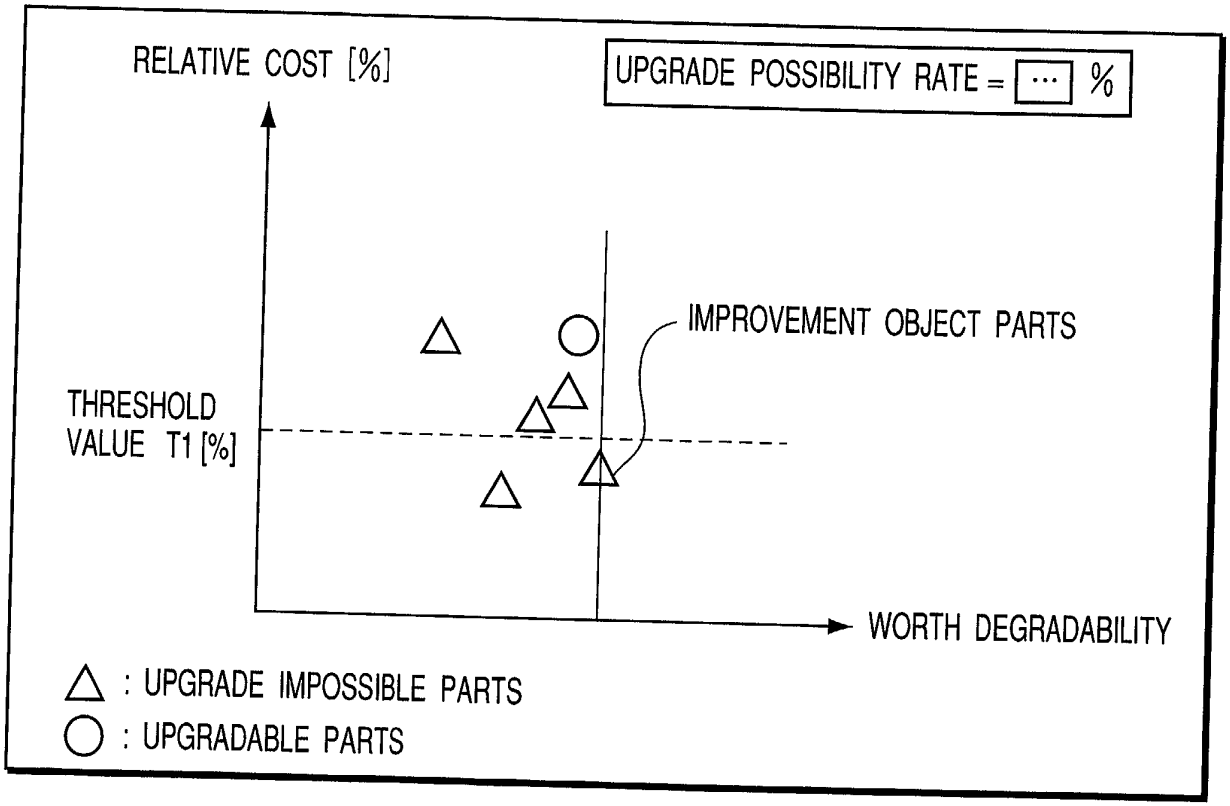

FIG. 9

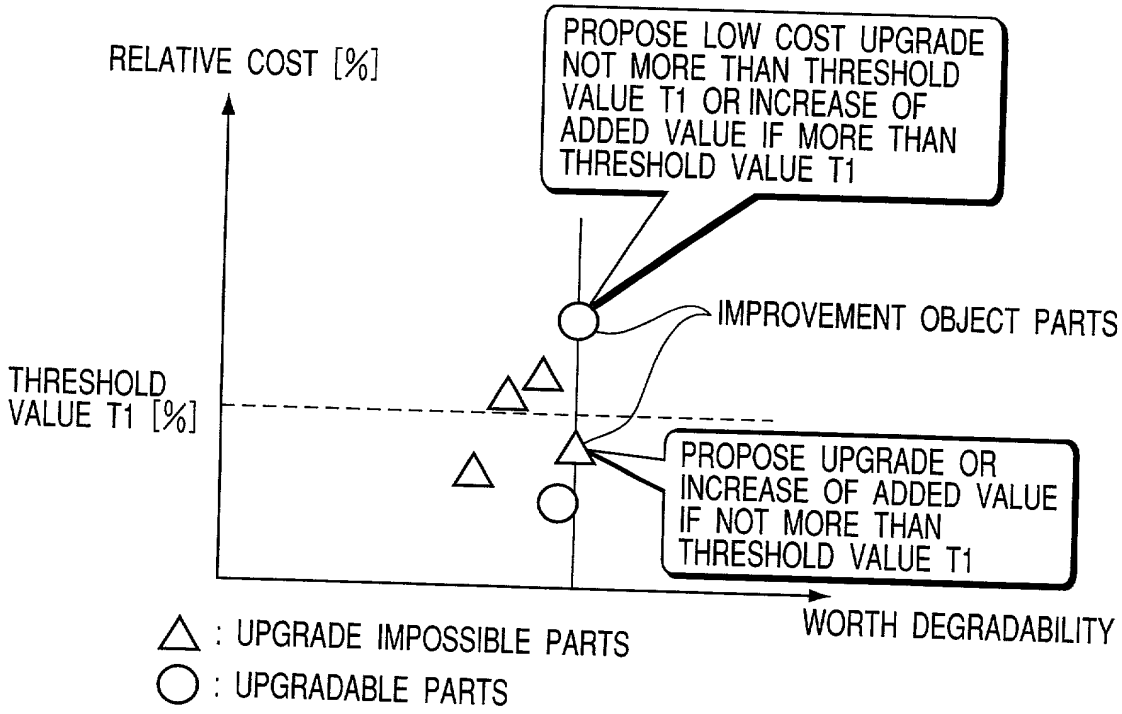
RELATIVE COST [%]
PROPOSE LOW COST UPGRADE NOT MORE THAN THRESHOLD VALUE T1 OR INCREASE OF ADDED VALUE IF MORE THAN THRESHOLD VALUE T1
IMPROVEMENT OBJECT PARTS
THRESHOLD VALUE T1 [%]
PROPOSE UPGRADE OR INCREASE OF ADDED VALUE IF NOT MORE THAN THRESHOLD VALUE T1
WORTH DEGRADABILITY
△ : UPGRADE IMPOSSIBLE PARTS
○ : UPGRADABLE PARTS

FIG. 10

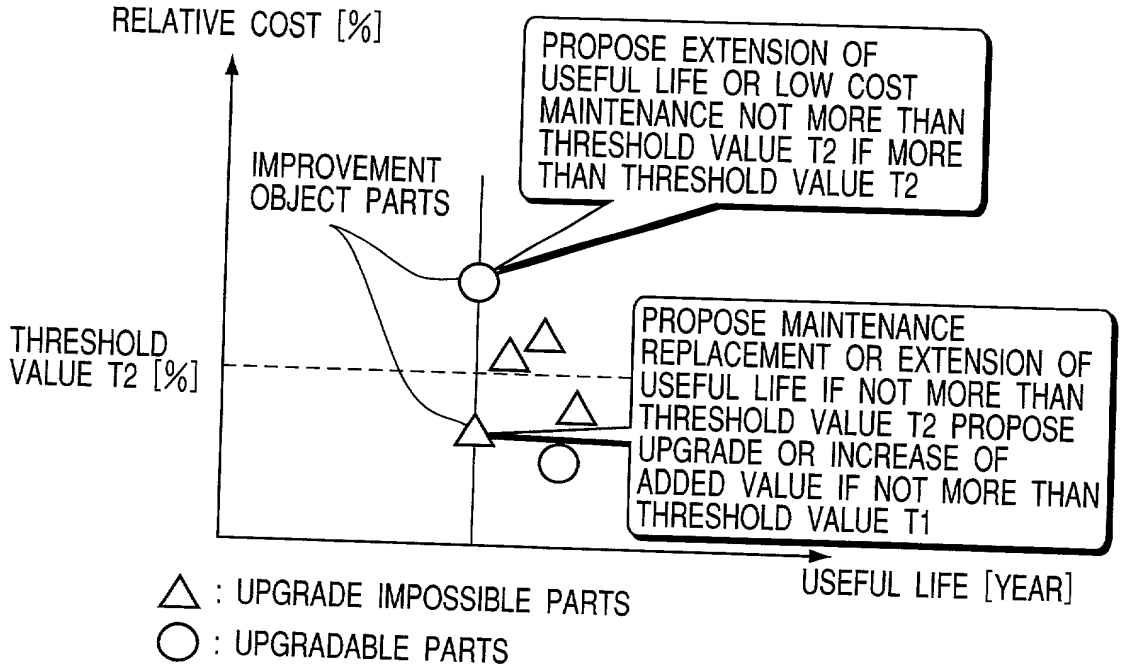
RELATIVE COST [%]
PROPOSE EXTENSION OF USEFUL LIFE OR LOW COST MAINTENANCE NOT MORE THAN THRESHOLD VALUE T2 IF MORE THAN THRESHOLD VALUE T2
IMPROVEMENT OBJECT PARTS
THRESHOLD VALUE T2 [%]
PROPOSE MAINTENANCE REPLACEMENT OR EXTENSION OF USEFUL LIFE IF NOT MORE THAN THRESHOLD VALUE T2 PROPOSE UPGRADE OR INCREASE OF ADDED VALUE IF NOT MORE THAN THRESHOLD VALUE T1
USEFUL LIFE [YEAR]
△ : UPGRADE IMPOSSIBLE PARTS
○ : UPGRADABLE PARTS

FIG. 14

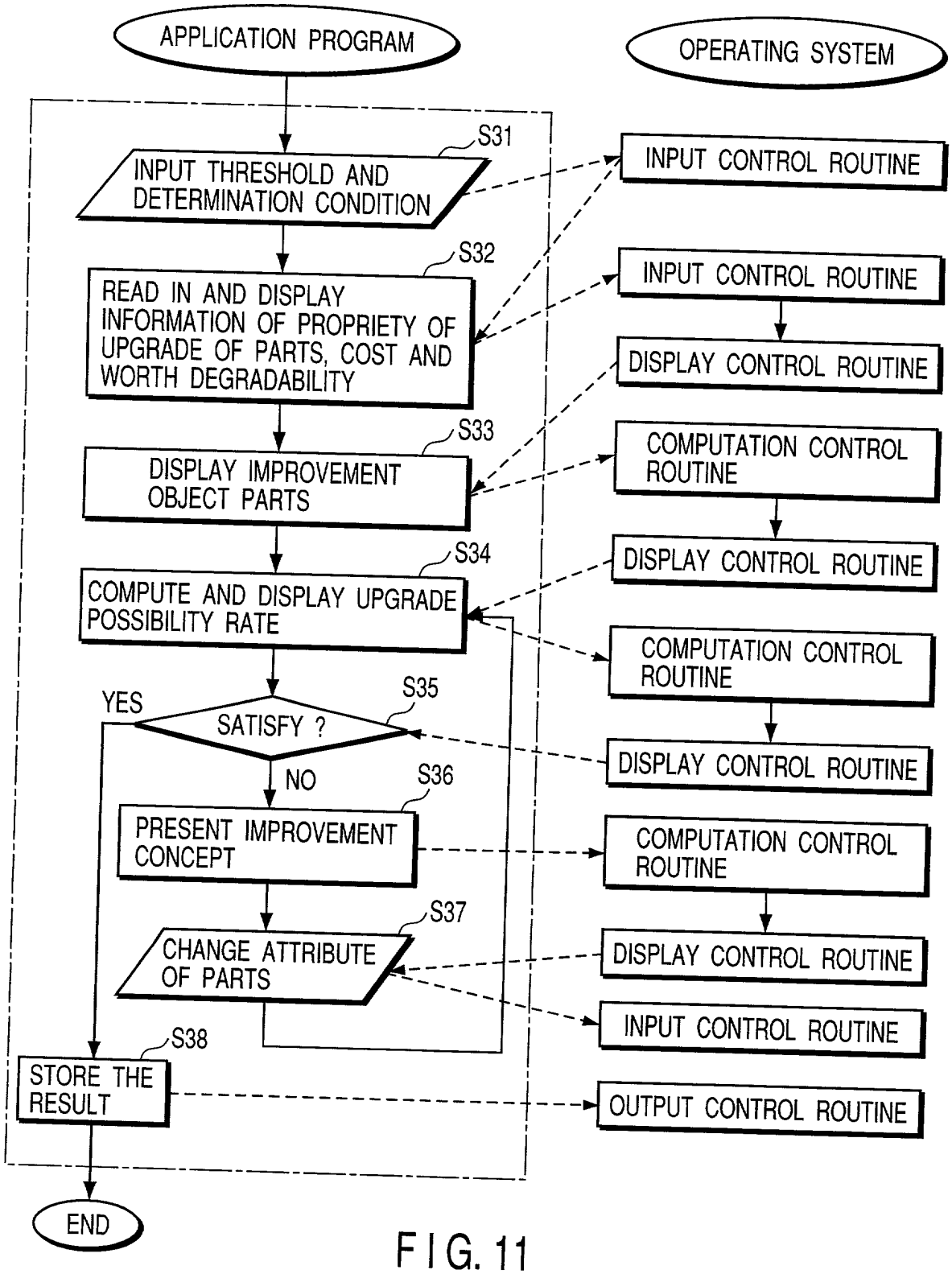
APPLICATION PROGRAM
OPERATING SYSTEM
S31
INPUT THRESHOLD AND DETERMINATION CONDITION
INPUT CONTROL ROUTINE
S32
READ IN AND DISPLAY INFORMATION OF PROPRIETY OF UPGRADE OF PARTS, COST AND WORTH DEGRADABILITY
INPUT CONTROL ROUTINE
DISPLAY CONTROL ROUTINE
S33
DISPLAY IMPROVEMENT OBJECT PARTS
COMPUTATION CONTROL ROUTINE
DISPLAY CONTROL ROUTINE
S34
COMPUTE AND DISPLAY UPGRADE POSSIBILITY RATE
COMPUTATION CONTROL ROUTINE
YES
S35
SATISFY ?
DISPLAY CONTROL ROUTINE
NO
S36
PRESENT IMPROVEMENT CONCEPT
COMPUTATION CONTROL ROUTINE
S37
CHANGE ATTRIBUTE OF PARTS
DISPLAY CONTROL ROUTINE
INPUT CONTROL ROUTINE
S38
STORE THE RESULT
OUTPUT CONTROL ROUTINE
END

FIG. 11

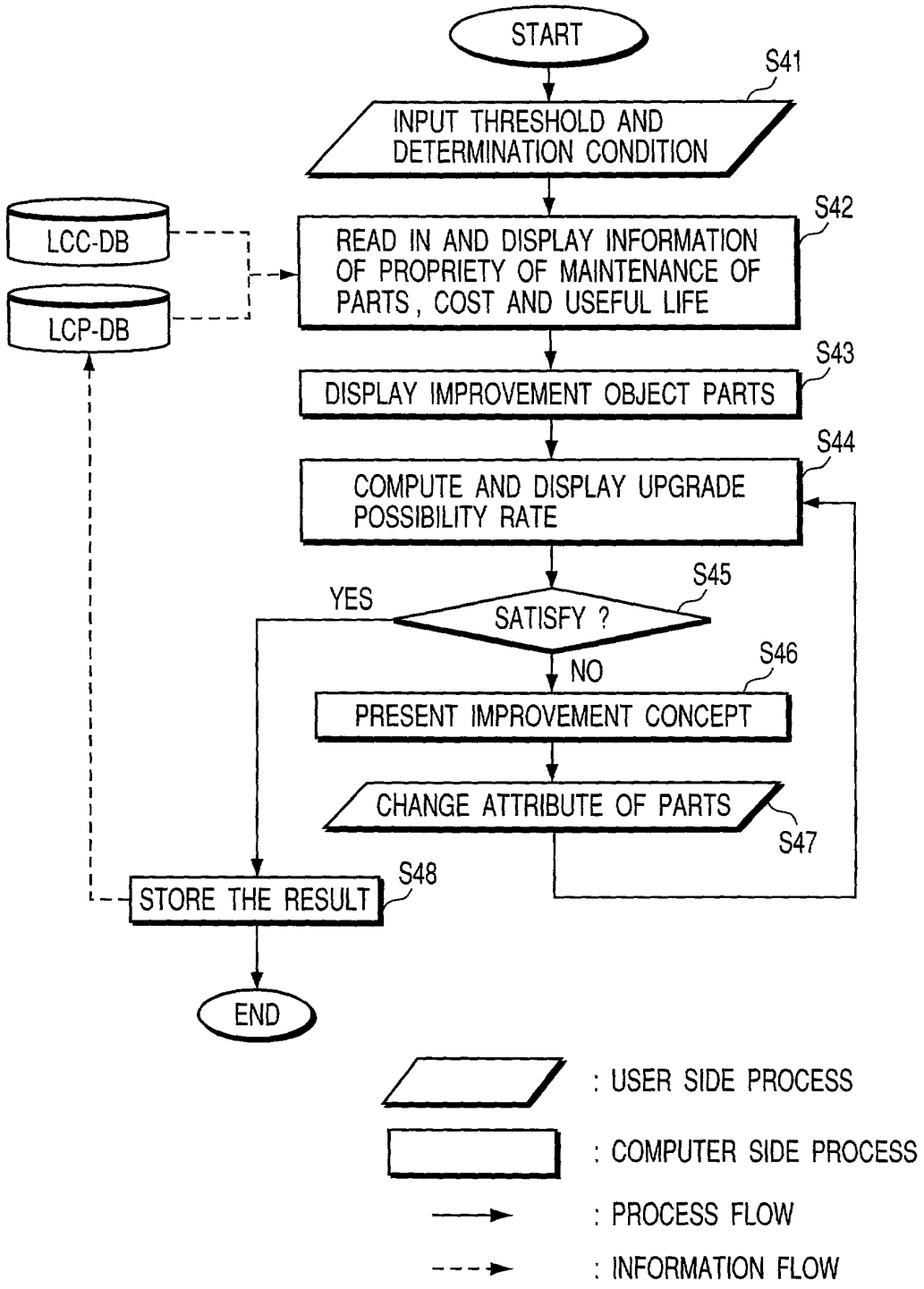
START
S41
INPUT THRESHOLD AND DETERMINATION CONDITION
LCC-DB
LCP-DB
S42
READ IN AND DISPLAY INFORMATION OF PROPRIETY OF MAINTENANCE OF PARTS, COST AND USEFUL LIFE
S43
DISPLAY IMPROVEMENT OBJECT PARTS
S44
COMPUTE AND DISPLAY UPGRADE POSSIBILITY RATE
S45
YES
SATISFY ?
NO
S46
PRESENT IMPROVEMENT CONCEPT
CHANGE ATTRIBUTE OF PARTS
S47
S48
STORE THE RESULT
END
: USER SIDE PROCESS
: COMPUTER SIDE PROCESS
: PROCESS FLOW
: INFORMATION FLOW

FIG. 12

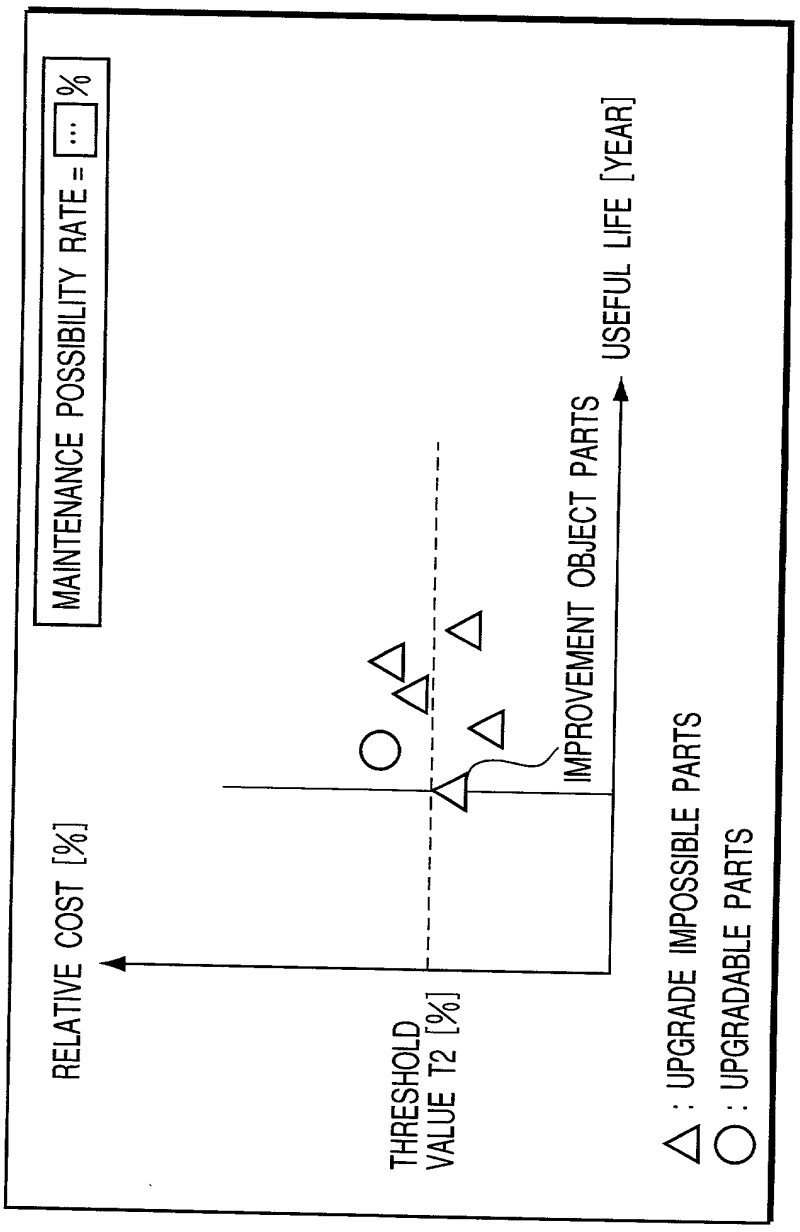
MAINTENANCE POSSIBILITY RATE = ··· %
RELATIVE COST [%]
THRESHOLD VALUE T2 [%]
IMPROVEMENT OBJECT PARTS
USEFUL LIFE [YEAR]
△ : UPGRADE IMPOSSIBLE PARTS
○ : UPGRADABLE PARTS

FIG. 13

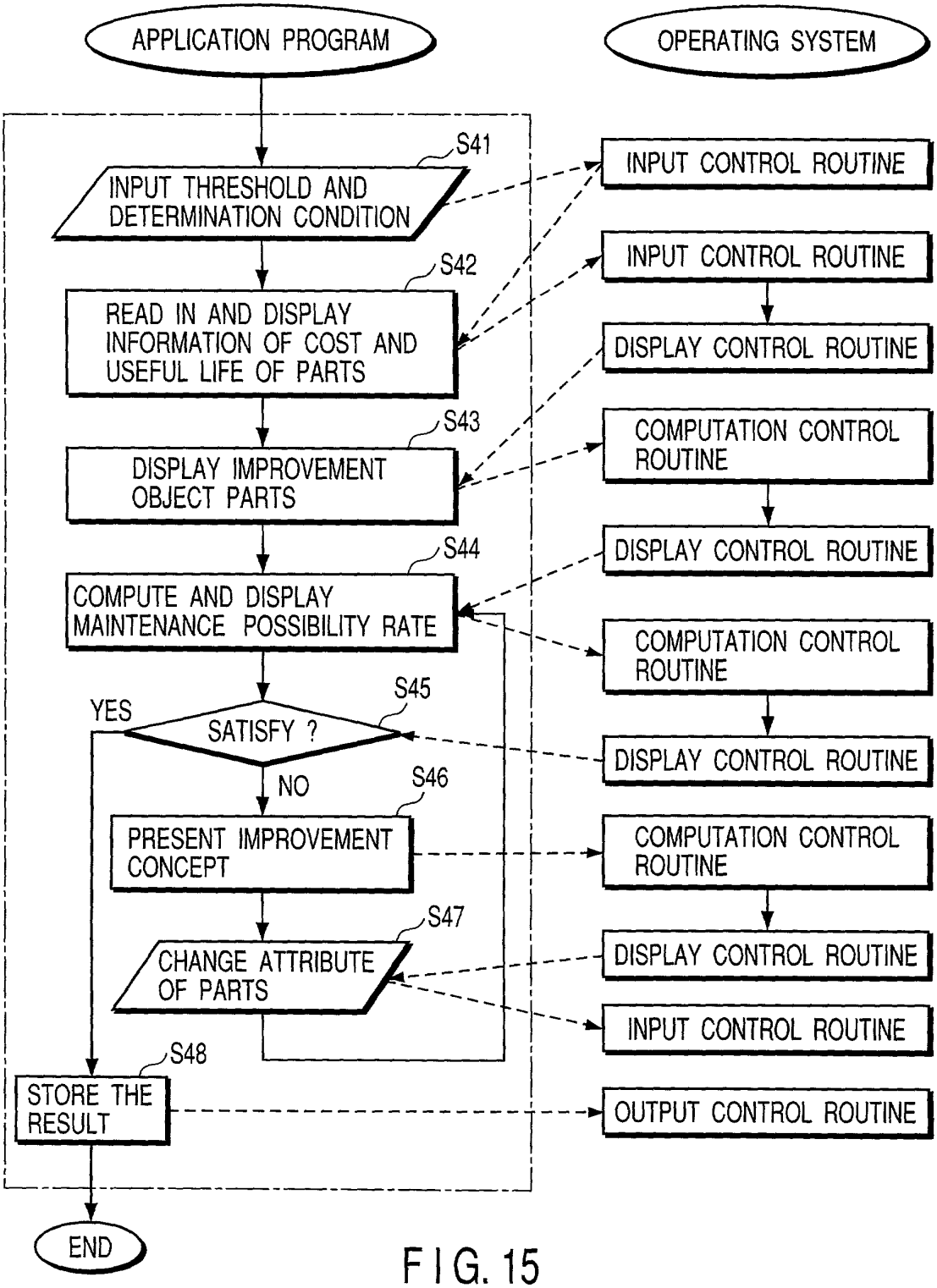
APPLICATION PROGRAM
OPERATING SYSTEM
S41
INPUT THRESHOLD AND DETERMINATION CONDITION
INPUT CONTROL ROUTINE
S42
READ IN AND DISPLAY INFORMATION OF COST AND USEFUL LIFE OF PARTS
INPUT CONTROL ROUTINE
DISPLAY CONTROL ROUTINE
S43
DISPLAY IMPROVEMENT OBJECT PARTS
COMPUTATION CONTROL ROUTINE
DISPLAY CONTROL ROUTINE
S44
COMPUTE AND DISPLAY MAINTENANCE POSSIBILITY RATE
COMPUTATION CONTROL ROUTINE
S45
YES
SATISFY ?
DISPLAY CONTROL ROUTINE
NO
S46
PRESENT IMPROVEMENT CONCEPT
COMPUTATION CONTROL ROUTINE
S47
CHANGE ATTRIBUTE OF PARTS
DISPLAY CONTROL ROUTINE
INPUT CONTROL ROUTINE
S48
STORE THE RESULT
OUTPUT CONTROL ROUTINE
END

FIG. 15

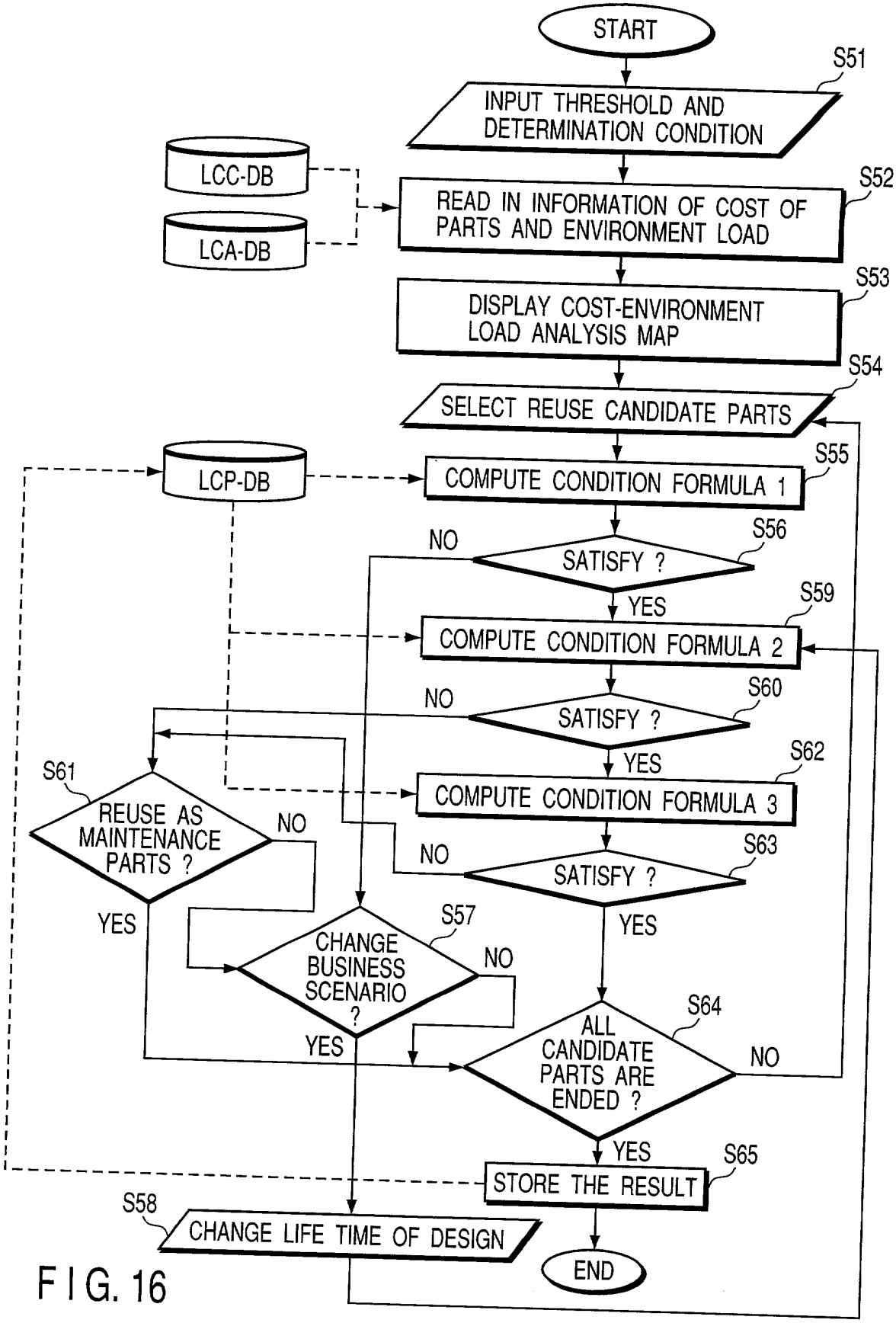
START
S51
INPUT THRESHOLD AND DETERMINATION CONDITION
LCC-DB
LCA-DB
S52
READ IN INFORMATION OF COST OF PARTS AND ENVIRONMENT LOAD
S53
DISPLAY COST-ENVIRONMENT LOAD ANALYSIS MAP
S54
SELECT REUSE CANDIDATE PARTS
LCP-DB
S55
COMPUTE CONDITION FORMULA 1
S56
NO
SATISFY ?
YES
S59
COMPUTE CONDITION FORMULA 2
S60
NO
SATISFY ?
YES
S62
COMPUTE CONDITION FORMULA 3
S61
REUSE AS MAINTENANCE PARTS ?
NO
YES
S63
NO
SATISFY ?
YES
S57
CHANGE BUSINESS SCENARIO ?
NO
YES
S64
ALL CANDIDATE PARTS ARE ENDED ?
NO
YES
S65
STORE THE RESULT
S58
CHANGE LIFE TIME OF DESIGN
END

FIG. 16

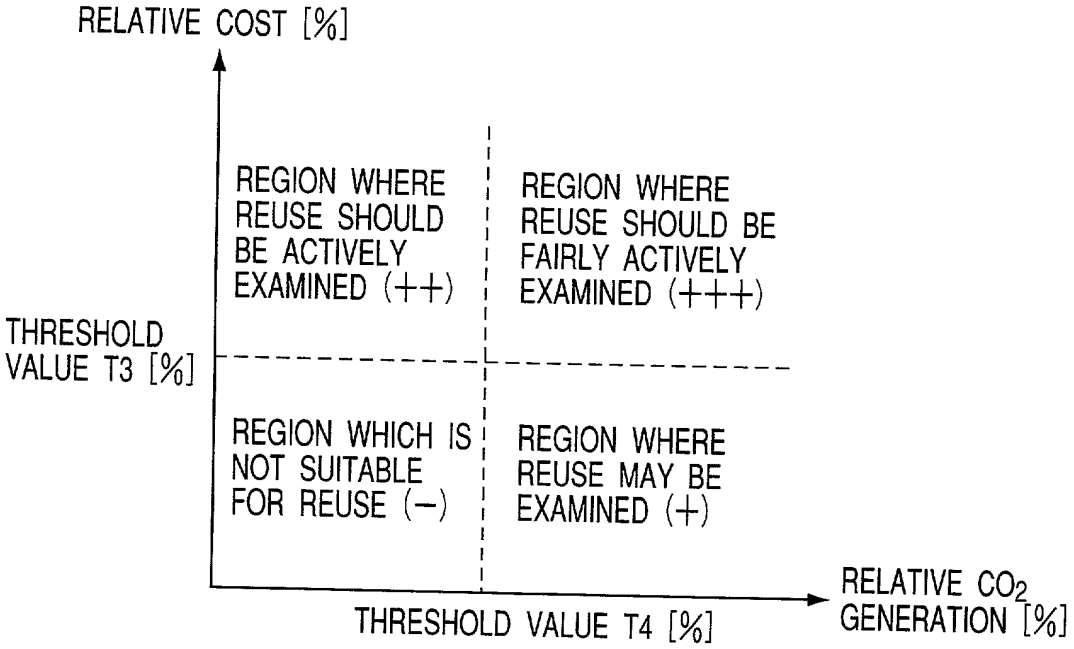
RELATIVE COST [%]
REGION WHERE REUSE SHOULD BE ACTIVELY EXAMINED (++)
REGION WHERE REUSE SHOULD BE FAIRLY ACTIVELY EXAMINED (+++)
THRESHOLD VALUE T3 [%]
REGION WHICH IS NOT SUITABLE FOR REUSE (−)
REGION WHERE REUSE MAY BE EXAMINED (+)
RELATIVE CO_2 GENERATION [%]
THRESHOLD VALUE T4 [%]

FIG. 17

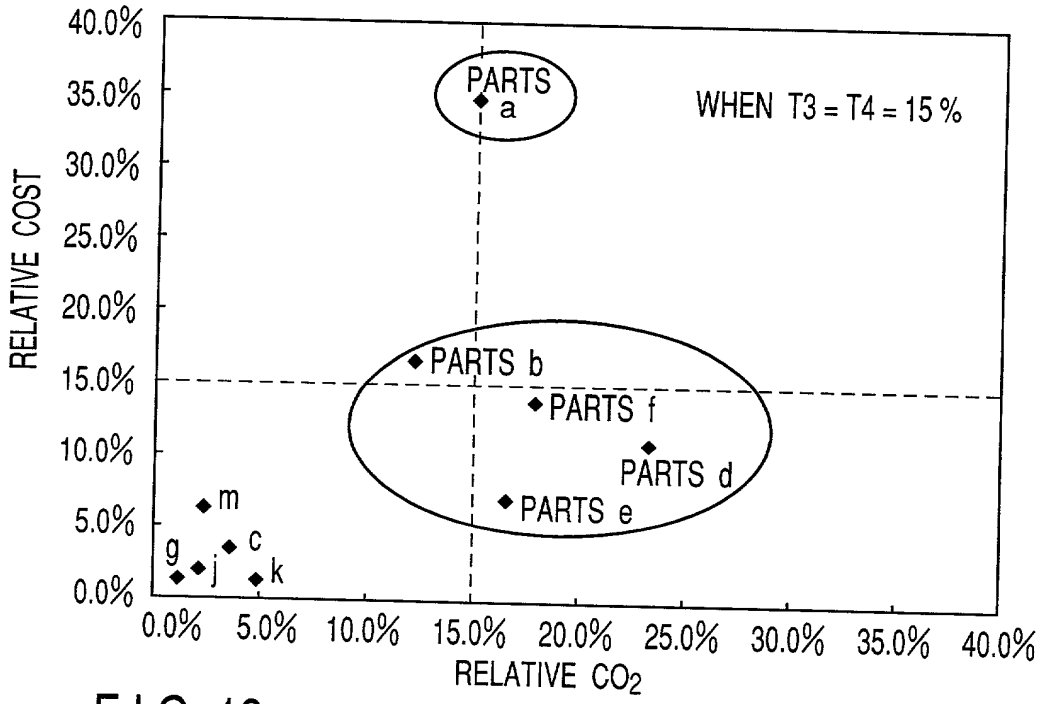
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
RELATIVE COST
PARTS a
WHEN T3 = T4 = 15 %
PARTS b
PARTS f
PARTS d
PARTS e
m
c
g
j
k
0.0%
5.0%
10.0%
15.0%
20.0%
25.0%
30.0%
35.0%
40.0%
RELATIVE CO_2

FIG. 18

- CONDITION FORMULA 1 : THE SIDE OF USEFUL LIFE

$$\min \{ {}^{\tilde{i}'}la, {}^{\tilde{i}'}lr \} \leq {}^{j}la - \min \{ {}^{\tilde{i}}la, {}^{\tilde{i}}lr \}$$

WHERE ${}^{\tilde{i}}l$ IS LIFE TIME OF PRODUCT, ${}^{j}l$ IS LIFE TIME OF PARTS

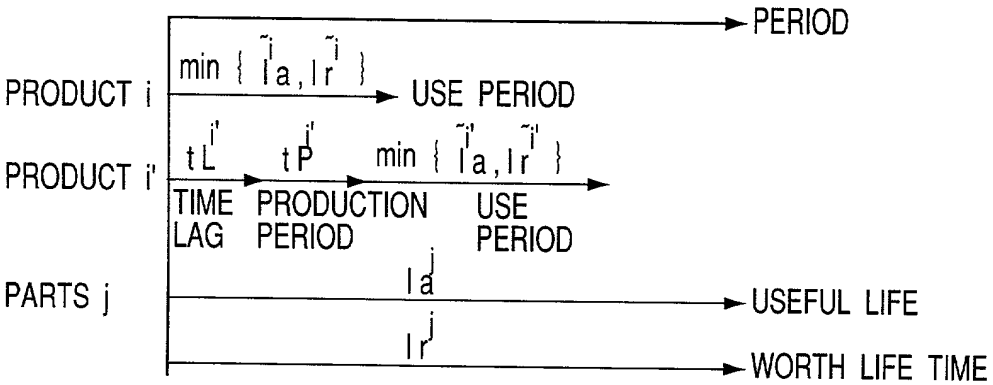

FIG. 19

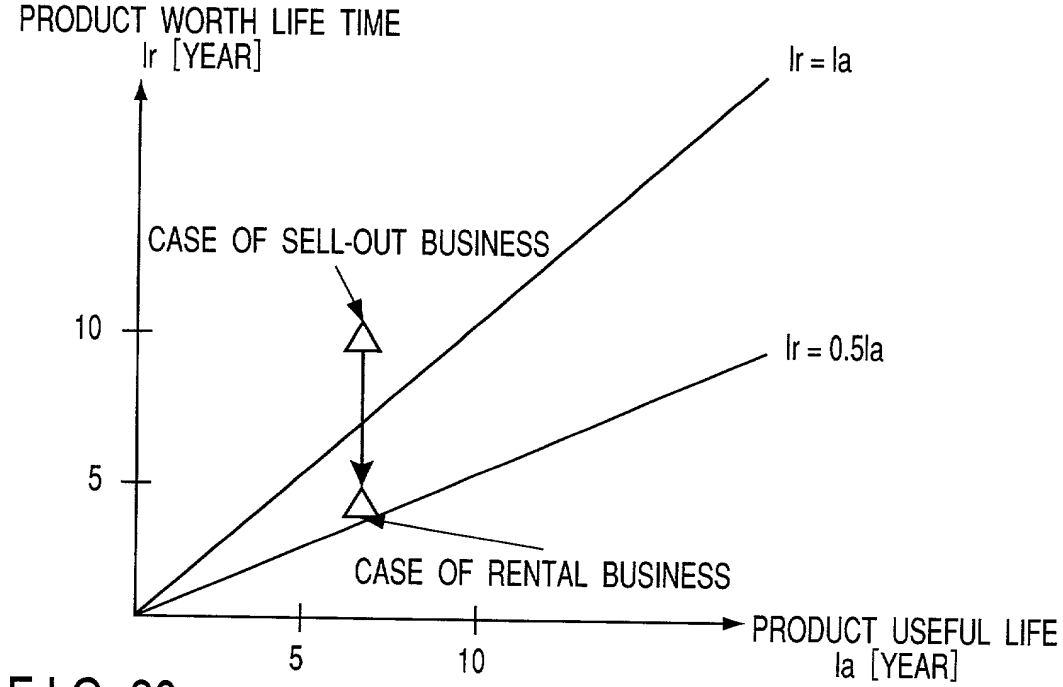

FIG. 20

- CONDITION FORMULA 2 : THE SIDE OF WORTH LIFE TIME

$$tL^{i'} + tP^{i'} + \min\{ {}^{\sim i}la, {}^{\sim i}lr^{i'} \} \leq lr^{j}$$

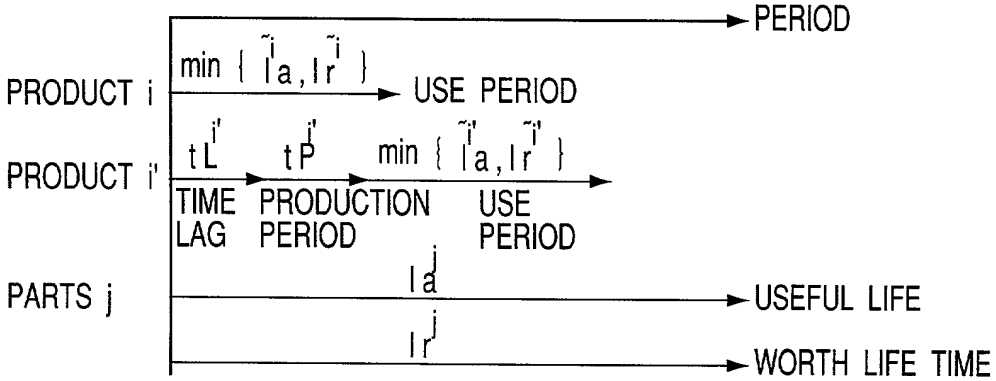

FIG. 21

- CONDITION FORMULA 3 : THE SIDE OF RECOVERY QUANTITY

$$\min\{ {}^{\sim i}la, {}^{\sim i}lr^{i'} \} < tL^{i'} + \alpha\, tP^{i'}$$

WHERE $0 \leq \alpha \leq 1$ α : PERIOD FACTOR

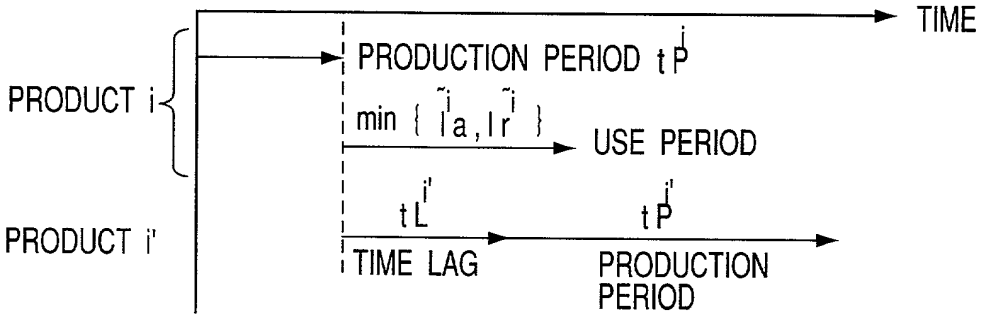

FIG. 22

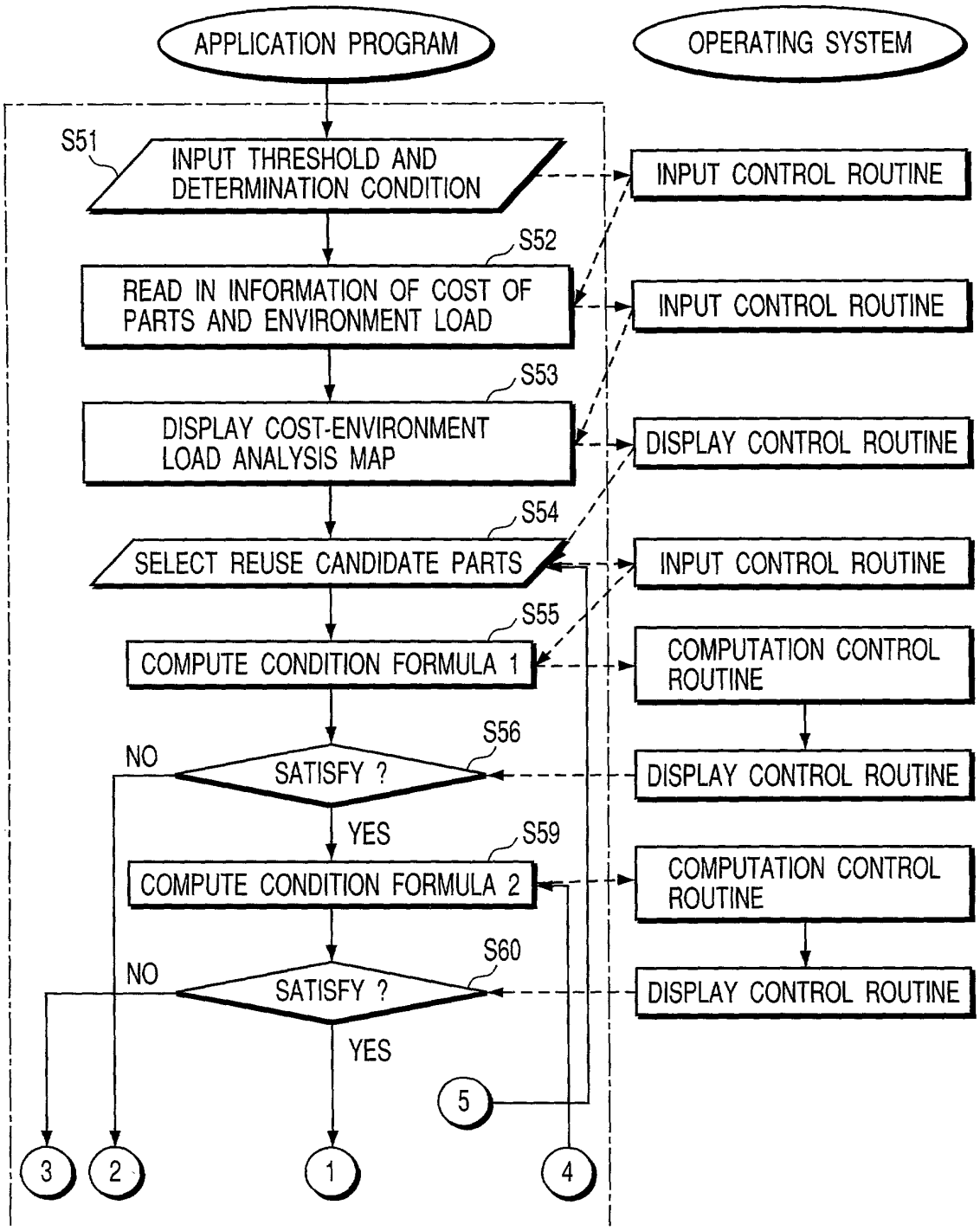
APPLICATION PROGRAM
OPERATING SYSTEM
S51
INPUT THRESHOLD AND DETERMINATION CONDITION
INPUT CONTROL ROUTINE
S52
READ IN INFORMATION OF COST OF PARTS AND ENVIRONMENT LOAD
INPUT CONTROL ROUTINE
S53
DISPLAY COST-ENVIRONMENT LOAD ANALYSIS MAP
DISPLAY CONTROL ROUTINE
S54
SELECT REUSE CANDIDATE PARTS
INPUT CONTROL ROUTINE
S55
COMPUTE CONDITION FORMULA 1
COMPUTATION CONTROL ROUTINE
S56
NO
SATISFY ?
DISPLAY CONTROL ROUTINE
YES
S59
COMPUTE CONDITION FORMULA 2
COMPUTATION CONTROL ROUTINE
S60
NO
SATISFY ?
DISPLAY CONTROL ROUTINE
YES
5
3
2
1
4

FIG. 23A

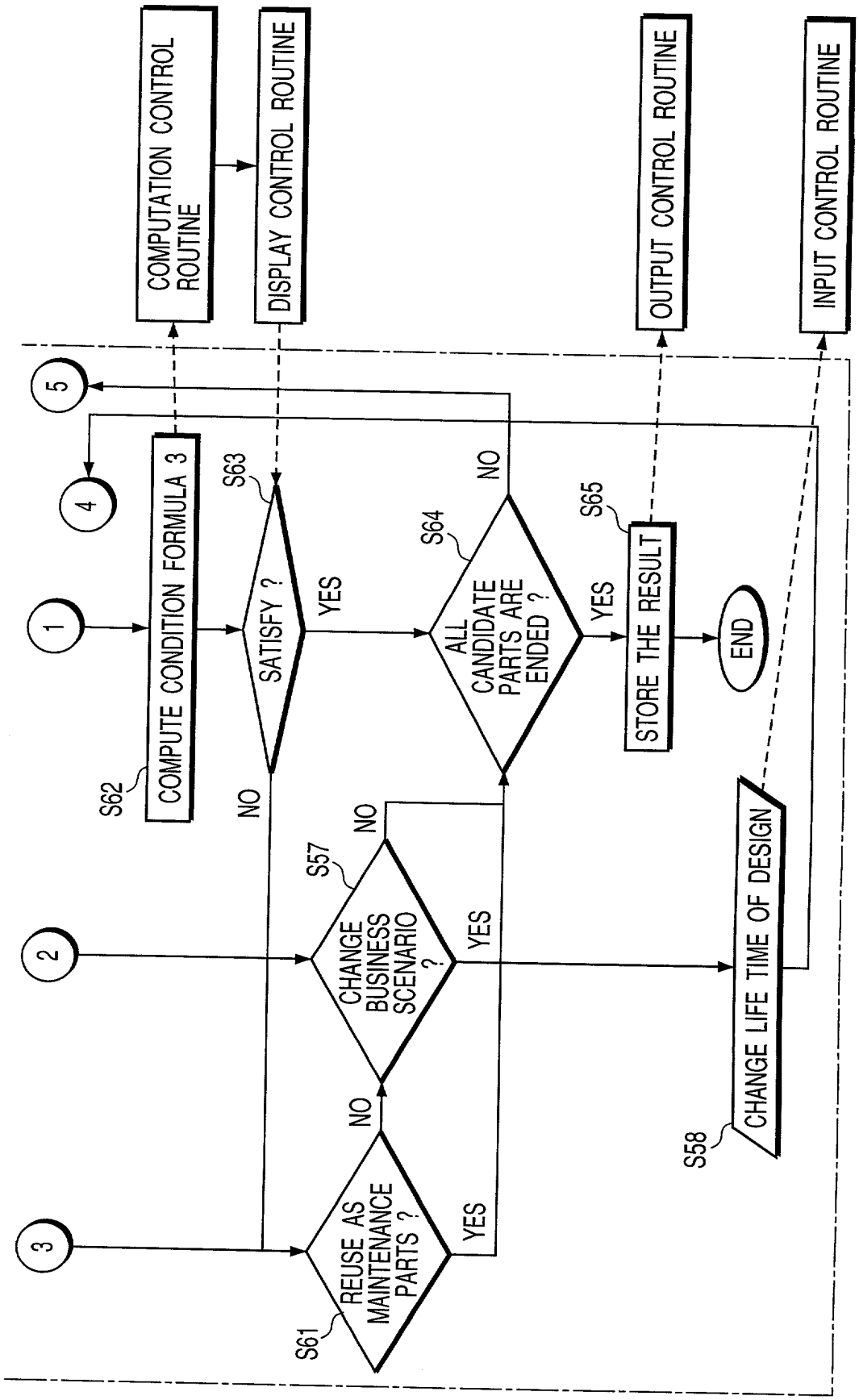
COMPUTATION CONTROL ROUTINE
DISPLAY CONTROL ROUTINE
OUTPUT CONTROL ROUTINE
INPUT CONTROL ROUTINE
1
2
3
4
5
COMPUTE CONDITION FORMULA 3
S62
SATISFY ?
S63
YES
NO
ALL CANDIDATE PARTS ARE ENDED ?
S64
YES
NO
STORE THE RESULT
S65
END
CHANGE BUSINESS SCENARIO ?
S57
YES
NO
REUSE AS MAINTENANCE PARTS ?
S61
YES
NO
CHANGE LIFE TIME OF DESIGN
S58

FIG. 23B

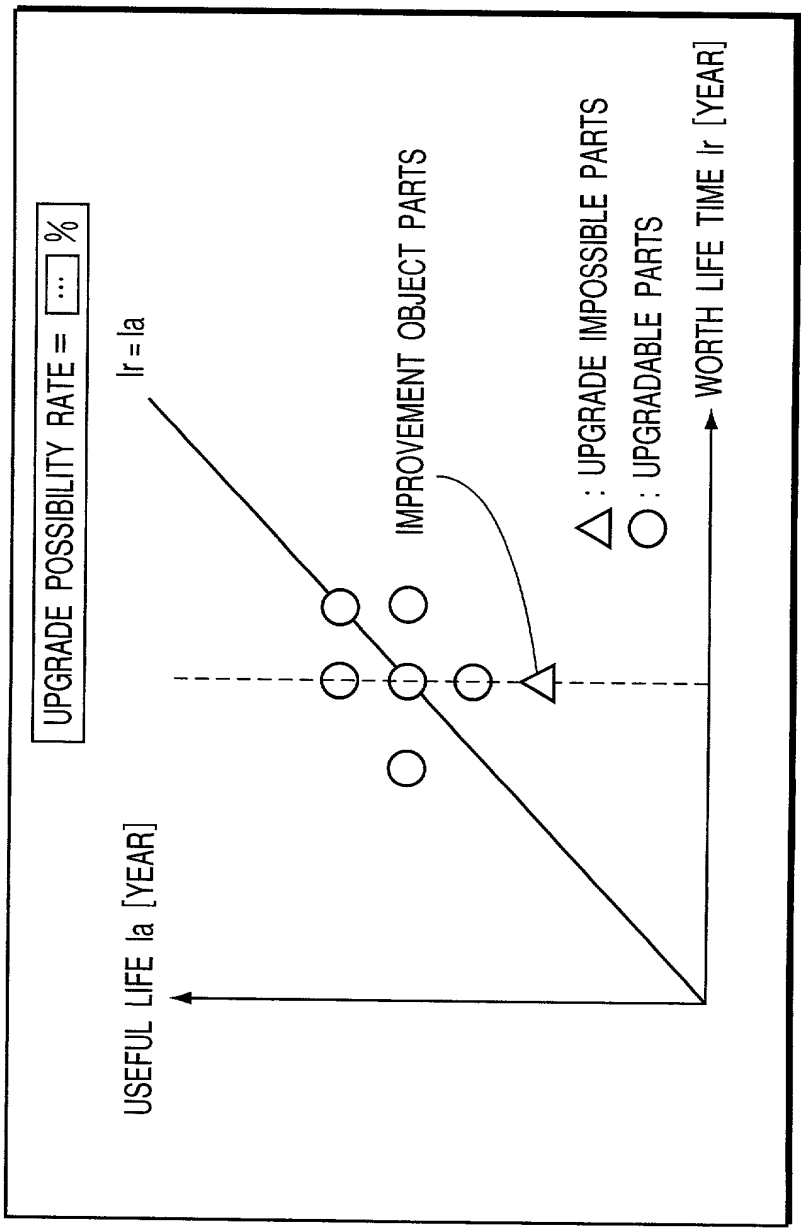
UPGRADE POSSIBILITY RATE = ··· %
USEFUL LIFE la [YEAR]
lr = la
IMPROVEMENT OBJECT PARTS
△ : UPGRADE IMPOSSIBLE PARTS
○ : UPGRADABLE PARTS
WORTH LIFE TIME lr [YEAR]

FIG. 24

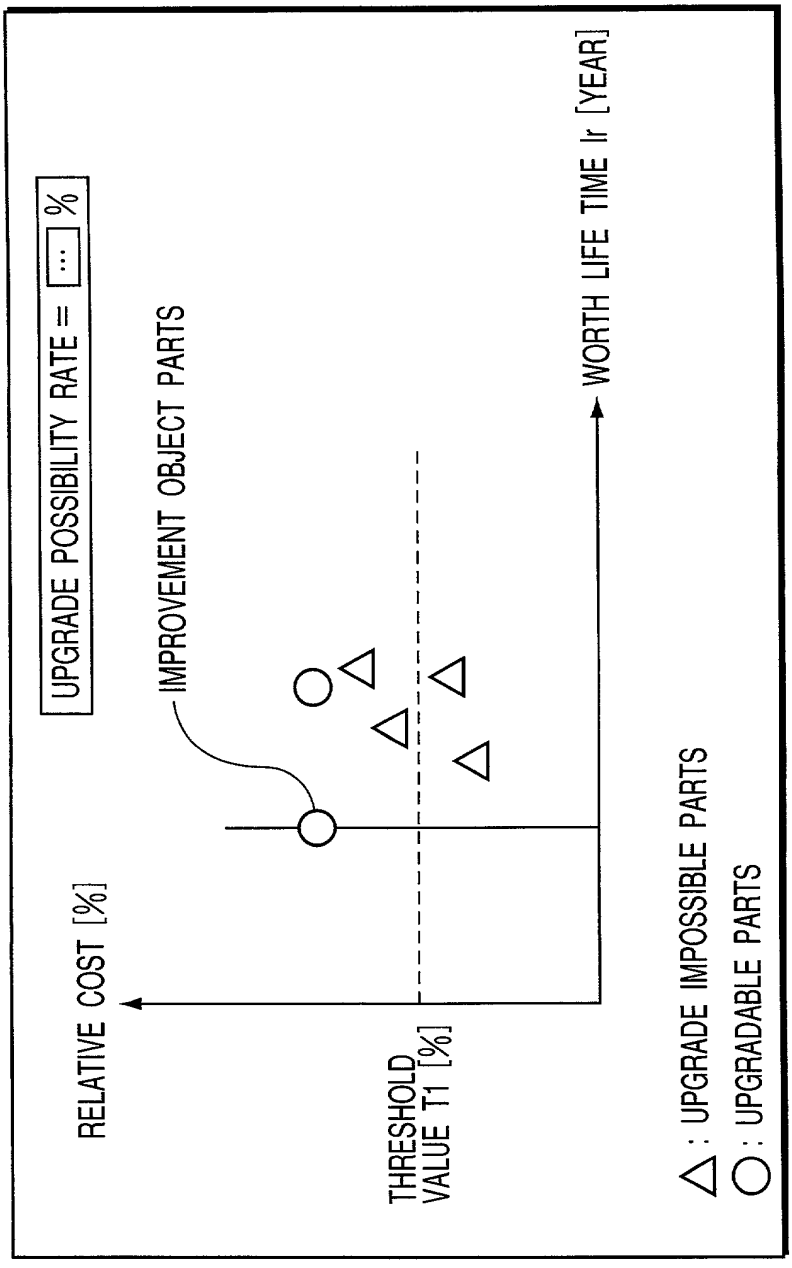
UPGRADE POSSIBILITY RATE = ... %
IMPROVEMENT OBJECT PARTS
RELATIVE COST [%]
WORTH LIFE TIME Ir [YEAR]
THRESHOLD VALUE T1 [%]
△ : UPGRADE IMPOSSIBLE PARTS
○ : UPGRADABLE PARTS

FIG. 25

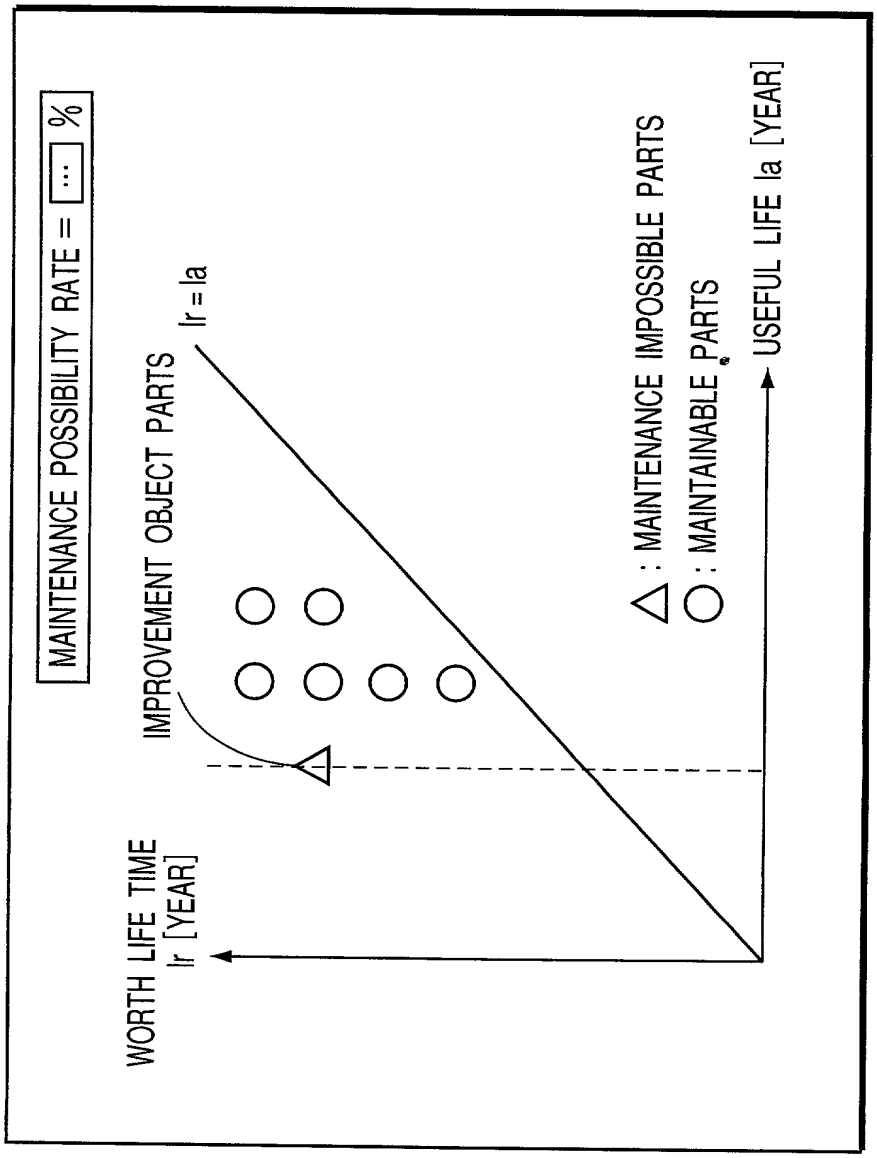
MAINTENANCE POSSIBILITY RATE = ... %
IMPROVEMENT OBJECT PARTS
Ir = Ia
WORTH LIFE TIME
Ir [YEAR]
△ : MAINTENANCE IMPOSSIBLE PARTS
○ : MAINTAINABLE PARTS
USEFUL LIFE Ia [YEAR]

FIG. 26

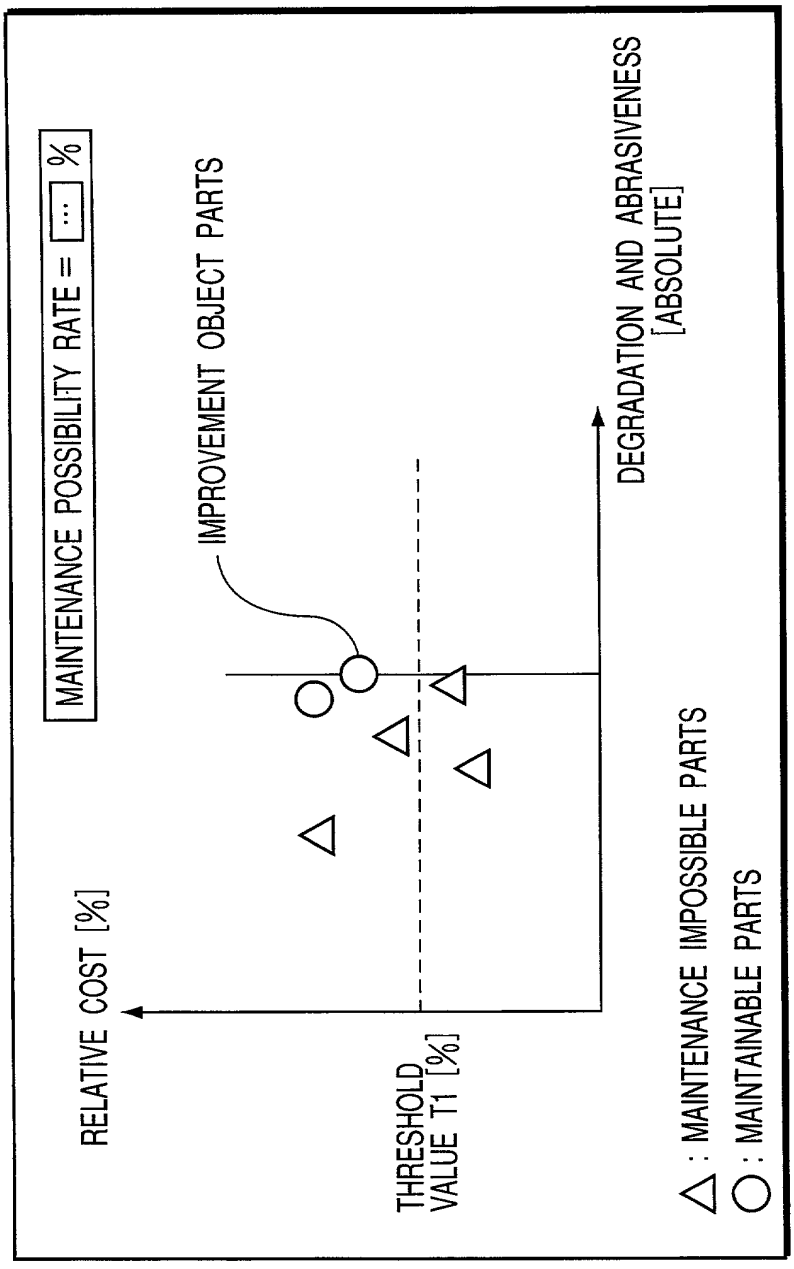
MAINTENANCE POSSIBILITY RATE = ... %
IMPROVEMENT OBJECT PARTS
RELATIVE COST [%]
THRESHOLD VALUE T1 [%]
DEGRADATION AND ABRASIVENESS [ABSOLUTE]
△ : MAINTENANCE IMPOSSIBLE PARTS
○ : MAINTAINABLE PARTS

FIG. 27

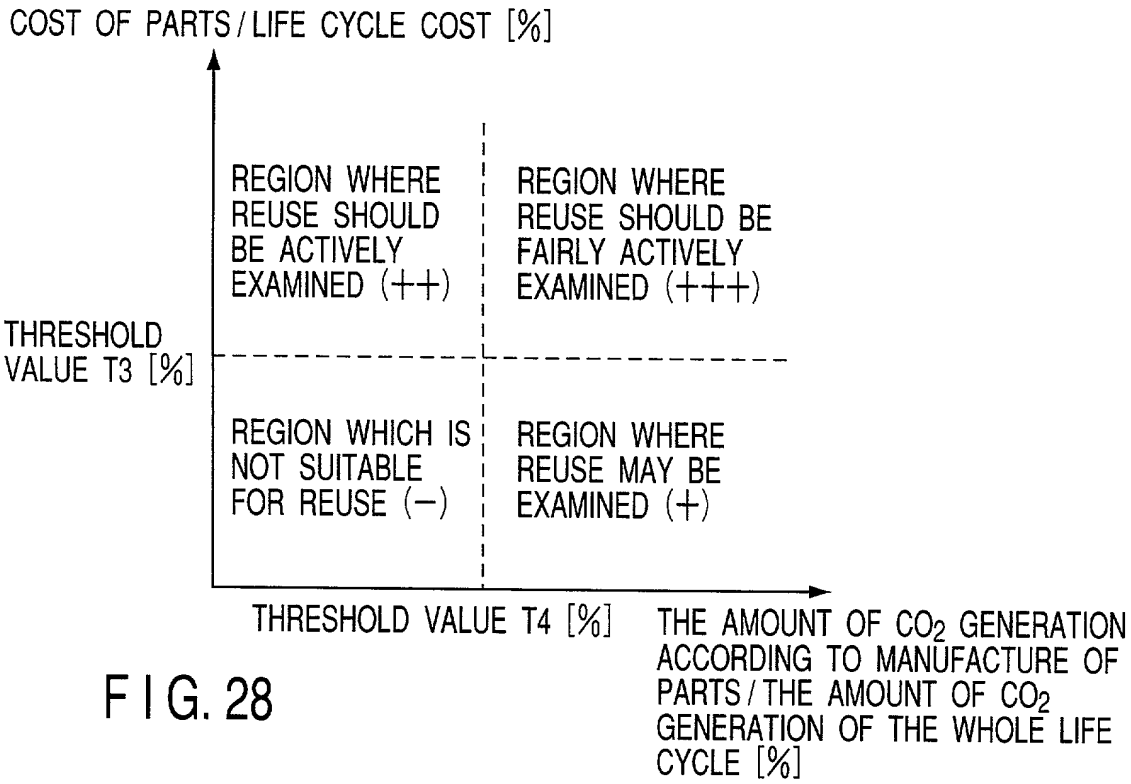
COST OF PARTS / LIFE CYCLE COST [%]
REGION WHERE REUSE SHOULD BE ACTIVELY EXAMINED (++)
REGION WHERE REUSE SHOULD BE FAIRLY ACTIVELY EXAMINED (+++)
THRESHOLD VALUE T3 [%]
REGION WHICH IS NOT SUITABLE FOR REUSE (−)
REGION WHERE REUSE MAY BE EXAMINED (+)
THRESHOLD VALUE T4 [%]
THE AMOUNT OF CO_2 GENERATION ACCORDING TO MANUFACTURE OF PARTS / THE AMOUNT OF CO_2 GENERATION OF THE WHOLE LIFE CYCLE [%]

FIG. 28

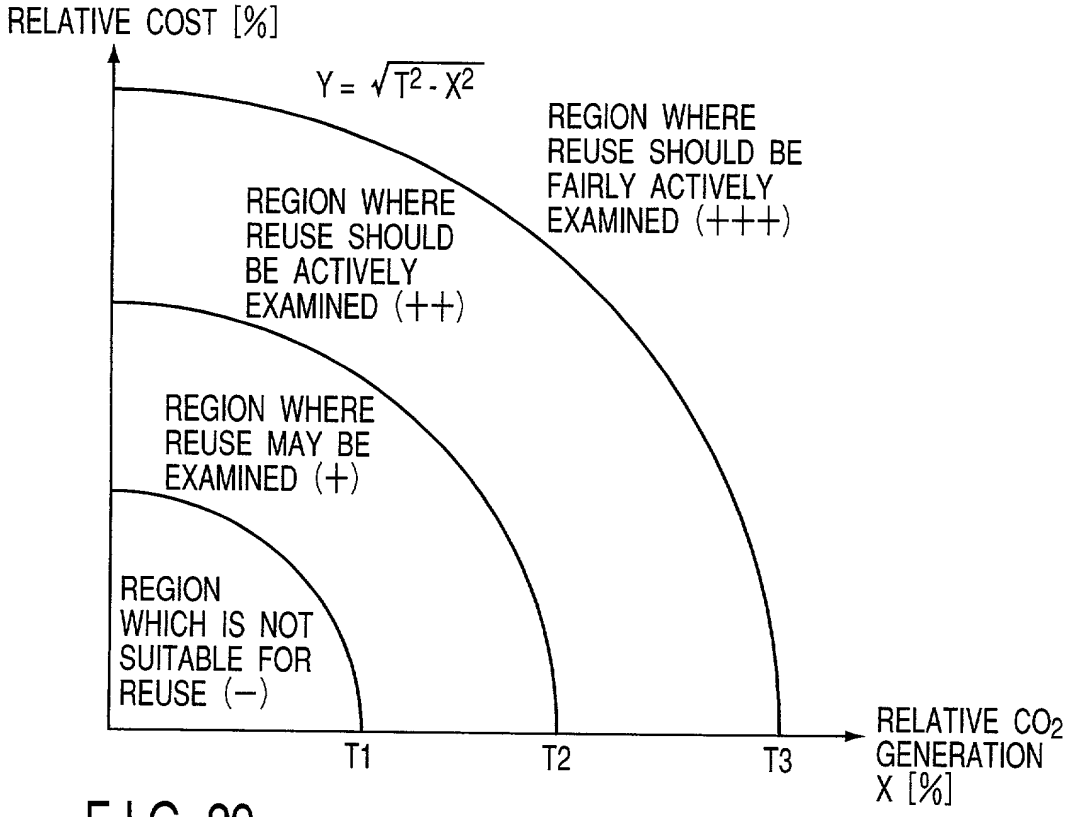
RELATIVE COST [%]
$Y = \sqrt{T^2 - X^2}$
REGION WHERE REUSE SHOULD BE FAIRLY ACTIVELY EXAMINED (+++)
REGION WHERE REUSE SHOULD BE ACTIVELY EXAMINED (++)
REGION WHERE REUSE MAY BE EXAMINED (+)
REGION WHICH IS NOT SUITABLE FOR REUSE (−)
T1
T2
T3
RELATIVE CO_2 GENERATION X [%]

FIG. 29